Being wholly cloudy, however, it is doubtful if we can ever demonstrate it.

The earth, therefore, still remains the only known abode of life, and her life depends absolutely on the sun's radiation. Recent studies have shown that this dependence rests on very narrow margins of safety. For instance, the oxygen of the upper atmosphere is induced to combine into the form of ozone by the influence of extreme ultra-violet solar rays, and yet the ozone formed is continually being reconverted into oxygen by the influence of still other extreme ultra-violet solar rays. Thus occurs a balance of these effects such that the upper atmosphere contains so minute a quantity of ozone as would make, if brought to earth, a gaseous layer only as thick as a cardboard. Yet this minute and almost fortuitous atmospheric constituent cuts off entirely the spectrum of the sun and stars beyond wave length 2,900 Ångstroms. The solar rays thus cut off, if they reached the earth, would destroy human sight and tissues by their powerful chemical activity. Of course, we could shield ourselves from these effects, but our ancestors who lived before the invention of spectacles would have lost their sight, or never attained it. Yet if the atmospheric ozone absorption reached only a little further, to 3,200 Angstroms, human and animal young would languish with the enfeebling disease of rickets, for the extreme ultra-violet rays are indispensable to proper mammalian growth.

As ozone absorbs to some extent even as far as 3,200 Ångstroms, a catastrophe might ensue if circumstances led to a small increase of the ozone content of our atmosphere. For this would eliminate indispensable rays of wave lengths 2,900 to 3,200 Angstroms. Such a catastrophe would attend such an alteration in the distribution of the extreme ultra-violet solar spectrum as would change materially the existing balance of influences tending to produce and destroy ozone.

This leads us to inquire if the sun is a constant star, and, if not, what is the character of its variation. The fluctuations of sun spots and other visible solar phenomena which have long been known prove, of course, that the sun is not absolutely constant. Within the last 22 years the Smithsonian Institution has made some thousands of determinations of the intensity of solar heating, which prove that the solar radiation increases several per cent at times of maximum solar activity. Apparently, too, the sun's surface presents appreciable inequalities of radiating power, so that the rotation of the sun leads to successive brief changes of the intensity received at the earth's surface. These changes are slight for red and infra-red rays, but grow more and more considerable for the shorter wave lengths. Pettit, indeed, observing with the narrow band of ultra-violet rays which silver transmits, centering at 3,160 Angstroms, finds alterations of over 100 per cent in their intensity. This means that if our eyes were sensitive to such rays alone we should find the sun's surface twice as bright at some times as at others.

Other solar phenomena exhibit interesting variations. Nearly 20 years ago Hale discovered magnetism in sun spots, and later over the sun's whole surface. Sun spots are apt to go in pairs, and Hale finds that if the advancing spot of a pair is a north pole in the northern solar hemisphere, it will be a south pole which leads in a spot pair in the southern hemisphere. But this state of things endures only through one 11-year sun-spot cycle. In the following cycle these polarities reverse, so that 22⅓ years are required to bring back the magnetic conditions to the starting point. Bjerknes has proposed an ingenious hypothesis to account for sun spots, their coolness, their going in pairs, the opposite magnetic polarity of the pair, and the reversal of polarity at each 11-year cycle. It depends on hydrodynamic principles and explains the phenomena as due to causes residing within the sun, not to gravitational influences of the planets.

It is well known that terrestrial magnetism reacts to solar activity, and so does the aurora as well. Bauer has shown that the earth's magnetic state marches closely with the intensity of solar radiation as measured by the Smithsonian Institution. Very recently Austin has found that the reception of long-range radio signals also marches hand in hand with the intensity of solar radiation.

The weather, too, so important to human concerns, seems to be affected by solar changes. The importance of this effect is still in controversy, so that I shall not stress it, but merely remark that time will tell. However, I must point out that the solar variation, though obviously associated with the 11-year sun-spot cycle, has hitherto seemed irregular, and therefore unpredictable. But now there seem to appear definite periodicities of 25⅝, 15, and 11 months, and certain harmonics of these periods, which, together with the 11-year period seem to make up the whole long-interval solar variation. If these definite periodicities should persist, we shall be in position to forecast for years in advance the principal solar variation and everything which may be found to depend upon it.

I should give but a feeble impression of the importance of sunlight to life if I should stop at this point. All plants grow by absorbing solar energy and using it to promote chemical reactions in a way still inimitable by chemists. Ultra-violet rays, too, produce certain changes of chemical structure in fats and oils which are the source of those traces of hormones so extraordinarily important, all out of proportion to their infinitesimal occurrence, in the growth and health of animals. The more searching study of the solar spectrum in its relations to these extraordinary chemical reactions is a most fascinating field.

On the grosser side the application of solar energy to power production also offers an attractive research field. Some are disposed to think this chimerical. There are, however, certain lines of improvement over former attempts at the utilization of solar rays directly for power which, I am inclined to think, will solve the problem commercially.—*C. F. B.*

The distribution of mean annual maxima and minima of temperature over the globe.—Dr. C. E. P. Brooks and Miss G. L. Thorman, in Geophysical Memoir, No. 44 (British Meteorological Office, 1928), present isothermal charts of the mean annual maxima and minima, and tables of the means for stations in each 10 degrees of latitude, an arrangement like that of the Reseau Mondial. The charts and tables are based upon data for the years 1910 to 1921. The authors felt that a temperature record of this sort was needed for two main reasons—first, because the mean extremes give an idea of the temperature conditions to be met, roughly speaking, one year in two. And secondly, in order to minimize the possible instrumental error in recording absolute maxima or minima. Mean extremes also are, for different periods, more nearly comparable than the absolute extremes. In plotting the data no correction was made for the height of the station above sea level, because, where the variation of the mean annual maxima and minima with height was investigated at several stations in the western United States, India, and Switzerland, no regular decrease with height was found, similar to that which exists in mean temperatures. The results indicate that in the case of mean annual maximum temperatures continentality has a greater effect than latitude, whereas in the case of mean annual minimum temperatures, latitude is of equal importance with continentality.—*N. H. B.* 551.46 (27)

Some remarkable features of the Gulf Stream, by P. Idrac (Comptes Rendus des seances de l'Academie des Sciences, Tome 188, No. 9, p. 644).—These studies were made this winter (1928–9) in the Florida Strait during the course of oceanographic researches assigned to me by Monsieur Claude in view of the installation on the coasts of Cuba of the first Claude-Boucherot works utilizing the thermal energy of the sea.

As is well known, the Gulf Stream is a warm current which, after being formed in the Gulf of Mexico, escapes toward the Atlantic Ocean through the passage about 70 miles wide and 1,000 to 1,800 meters deep separating Cuba from the reefs west of the point of Florida.

For four different dates in a period of three months I was able to construct thermal cross sections of the strait, each obtained from some 50 measurements to a depth of 1,000 meters well distributed over the whole extent of the strait, each of these measurements being checked by the simultaneous reading of two upsetting thermometers.

Some simultaneous measurements of the current were made from the surface to a depth of 1,400 meters by means of the recording apparatus for velocity and direction described in an earlier paper (Courants sousmarins de Gibraltar, Comptes Rendus, 186, 1928, p. 1058). The drift of the boat was reckoned from bearings of the land. The effect of the wind and the swell was eliminated by plunging the apparatus some meters below the surface, which gave the proper drift of the boat relative to the surface current. The apparatus was then lowered to different depths to obtain the velocity of the deep current relative to the drift of the boat, whence there could be deduced by a simple graph the actual velocity of the deep current.

Better than all explanations the figures give an idea of the structure of the Gulf Stream and of the rapid thermal variations which can in certain cases amount to more than 5° C. in five days.

Fortunately for the project of Monsieur Claude all of this variability fades out much below the depth of 800 meters, which appears scarcely touched by the Gulf Stream except when it is very strong. At 1,000 meters, for example, there is almost uniformly a temperature of 5° C. in the entire length of the channel.

The bulk of the current is generally nearer to the coast of Cuba than to the Florida Keys. It approaches or recedes, it seems, in a rather irregular manner, but in a manner that is without doubt connected with the extent of the cold current from Labrador, which extends, as is seen in the figures, along the coast of Florida, where it gives, at equal depth, lower temperatures than those on the Cuban coast.

At the surface the axis of the current of the Gulf Stream generally coincides roughly with the axis of the highest temperatures (yet when the Gulf Stream recedes from the Cuban coast the surface in that vicinity remains warm). Each time that we were able to make measurements we found that in the depths the axis of the current did not coincide with the vertical axis of the surface current and was plainly shifted toward the Cuban coast.

Where it is strongest (having a velocity of 3 knots in the period of our measurements) the current remains rather constant from the surface to a depth of 300 meters and then gradually weakens. Sometimes there are still found currents of 1 knot at the depth of 500 meters and of 0.5 knot at the depth of 1,000 meters.

From the results obtained there can be deduced the approximate discharge of the Gulf Stream. This, too, is very variable; for example, it was of the order of 50 cubic kilometers per hour on December 1, 1928, but amounted to about 90 cubic kilometers per hour on January 31, 1929.

Without doubt it would be interesting in the general study of the currents of the Atlantic Ocean and, perhaps, even of the climatic variations of western Europe to make periodic measurements of the discharge of this mighty river of warm water.

The first four figures (not reproduced) represent the thermal cross sections, on different dates, of the Strait of Florida between Havana and the Florida Keys. There will be noted, among other things, the rapidity of variation between November 26 and December 1, 1928.

The last figure shows the form of the current of the Gulf Stream off Havana. The heavier the shading, the stronger the current. The prolongation of the beds of the deep current toward Havana appears to be due to the influence of the cold current coming from Labrador and skirting the coast of Florida in the depths.—*Translated by W. W. Reed.*

Early meteorological observations in northern Michigan.—We are indebted to Nathan C. Rockwood, editor-manager of Rock Products of Chicago, Ill., for nine months meteorological observations made at Michilimackinac, Mich. (present Mackinac), by Captain Dunham from August, 1802, to April 1803, both inclusive. The observations came into Mr. Rockwood's possession through his great-grandfather William Dandridge Peck, professor of natural history at Harvard and an early American scientist. The observations were made three times daily at sunrise, noon, and sunset. The mean temperature has been computed by taking one-third of the sum of the means for the times mentioned, the resulting means being quite close to those that would be obtained from the daily extremes.

The temperatures recorded by Captain Dunham do not differ greatly from those made at Cheboygan, Mich., a short distance from Mackinac, in more recent times—the summary as prepared by the Climatological Division of the Weather Bureau follows.—*A. J. H.*